9th International Workshop on 2D Materials

Title of the Presentation: Van der Waals Schottky gated MoS_2 metal-semiconductor field-effect transistor at the Schottky-Mott limit

First Name: Yeon Ho

Last Name: Kim

Affiliation: KU-KIST Graduate School of Converging Science and Technology, Korea University, Seoul, Korea

Email: julianus95@korea.ac.kr

Short Biography:

Yeon Ho Kim received his B.S. from the Department of Material Science and Engineering of Korea University, Korea. He is currently Ph.D candidate at KU-KIST Graduate School of Converging Science and Technology, Korea University. His research interests are the electrical characteristics of 2D semiconductors and their application to low power electronics.

Abstract:

Van der Waals (*vdW*) semiconductors such as transition metal dichalcogenides (TMDs) have emerged as a promising material for next-generation electronics due to excellent gate coupling and low subthreshold slope even at the atomic scale. To achieve high-performance electronic devices, the gate stack that enables the effective electrostatic control of the TMD channel is necessary. In this regard, the metal-semiconductor junction can be a promising alternative considering that appropriate gate dielectrics are not available except hexagonal boron nitride. Nevertheless, control of the metal-*vdW* semiconductor junction is still challenging because of unavoidable Fermi-level (E_F) pinning originated from either metal-induced gap states (MIGS) or disorder-induced gap states (DIGS).

Here, we propose a new device architecture of *vdW* metal-semiconductor field-effect transistors (MESFETs) with the E_F pinning-free Schottky gate. The E_F depinning is achieved by forming the *vdW* metal-semiconductor (MS) junction between the TMDs and the surface-oxidized metals due to the suppression of both DIGS and MIGS. Utilizing such a *vdW* Schottky gate, the *vdW* MESFETs with low-power and stable operation were demonstrated. The ON/OFF switching via the E_F modulation of the TMD channel occurred within a voltage range of 0.8 V owing to effective gate coupling. More importantly, the devices exhibited excellent transfer characteristics with the subthreshold swing of 60 mV/dec and negligible hysteresis, approaching the nearly intrinsic Boltzmann limit. Due to the steep switching characteristics of the *vdW* MESFET, a voltage gain close to 40 V/V was obtained at V_{dd} = 2.0 V from the serial-connected inverter. Furthermore, the E_F depinning effect in the *vdW* Schottky gate, approaching the Schottky-Mott limit, were verified by investigating the modulation of Schottky barrier heights of various *vdW* junctions with different work functions.

[1] Y. Kim et al., In preparation.